

ECTOPARASITIC NEMATODES PATHOGENIC TO CITRUS

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INTRODUCTION: In various regions of the world, at least 44 genera and more than 200 species of plant parasitic nematodes are known to be associated with citrus (2, 8, 20, 21). For most of these nematode species, critical studies have not been conducted to confirm if they are pathogenic or capable of causing physiological and morphological abnormalities of citrus. There are, however, 20 species of phytoparasitic nematodes that are known to be pathogenic to citrus (Table 1). Ten of the species have an endoparasitic or semi-endoparasitic relation with their host, i.e., they feed and reproduce either completely or partially inside citrus



Fig. 1. Symptoms on rough lemon seedlings caused by sting nematodes, Belonolaimus longicaudatus. Left, noninoculated seedling; right, plants with reduced root systems inoculated with sting nematode. (Photo courtesy of F. W. Bistline.)

roots. These are: Radopholus similis (Cobb) Thorne; Pratylenchus brachyurus (Godfrey) Filipjev & Schuur. Stekhoven; P. coffeae (Zimmermann) Filipjev & Schuur. Stekhoven; P. vulnus Allen & Jensen; Tylenchulus semipenetrans Cobb; Meloidogyne exigua Goeldi; M. incognita (Kofoid & White) Chitw.; M. indica Whitehead; M. javanica Treub. (Chitw.); and an undescribed Meloidogyne species known as the 'Asiatic pyroid citrus nema'. Three of these 10 species, the burrowing nematode, R. similis, the citrus nematode, T. semipenetrans, and the coffee root lesion nematode, P. coffeae, have the potential to cause decline and serious economic losses to Florida citrus (17). These and other endoparasitic nematodes can readily be detected by sampling citrus roots.

It should be recognized, however, that one-half of the total number of nematode species known to be pathogenic to citrus will normally be detected only if the soil around citrus roots is analyzed. These are ectoparasitic nematodes which move freely in the soil outside the roots and penetrate root cells with only their stylet. It is more difficult to detect and assess the damage caused by ectoparasitic nematodes, and because of this they may be frequently overlooked when problems of citrus are diagnosed. The 10 species of ectoparasitic nematodes known to be pathogenic are listed in Table 1.

HOST SYMPTOMS AND DAMAGE CAUSED BY ECTOPARASITIC NEMATODES:

Sting nematode. In Florida, Belonolaimus longicaudatus Rau was detected in 5% of 288 groves surveyed in 1977-1978 (13). Sting nematode is associated with dieback and leaf chlorosis of citrus in Florida (22). Greenhouse studies and applications of nematicides in groves have confirmed the pathogenicity of this nematode to citrus. This nematode may cause root lesions and greatly reduce the root systems of young seedlings (Fig. 1.) (4).

Sheath nematodes. Hemicycliophora arenaria Raski causes damage to citrus in Southern California. It feeds on the epidermal and cortical cells near the root tip and causes swelling or galls on lateral and terminal roots. At 5 months, growth of infected rough lemon seedlings was reduced 36% compared to control plants (25). Similar symptoms have been observed on citrus roots parasitized by H. nudata Colbran, in Australia (11).

Lance nematode. In India, high populations of Hoplolaimus indicus Sher were found in citrus groves with declining yields. Greenhouse studies confirmed that this nematode may greatly reduce plant growth. This ectoparasitic nematode reduced the fresh shoot and root weights of all six species of citrus which were tested, but H. indicus was most pathogenic to rough lemon, Citrus limon (L.) Burm. f. and sweet orange, Citrus sinensis (L.) Osbeck (15).

Stubby root nematodes. Species of Trichodorus were found in about 8% of the groves surveyed in Florida in 1977-1978. The most common species was Trichodorus christiei Allen, which is known to be pathogenic to citrus. This nematode feeds in the root meristematic region and reduces normal root elongation (22). Similar symptoms are caused by T. porosus Allen, in California (3). In Australia, high numbers of T. lobatus Colbran were found in the rhizosphere of declining citrus. Greenhouse studies demonstrated that this nematode may cause swollen feeder root tips, stunted growth, and mild leaf chlorosis of citrus (23).

Dagger nematodes. Species of Xiphinema are widespread in citrus-growing regions of the United States. Worldwide, 14 species of Xiphinema have been associated with citrus (2). Pathogenicity to citrus has been confirmed for three of these species. In Israel, X. brevicolle Cohn and X. index Radewald & Raski reduced the growth of sour orange Citrus aurantium L. seedlings 44% and 46%, respectively (9). In Sudan, X. basiri Siddiqi caused swollen and stubby roots and severely reduced total root size of citrus. In the field, high populations of this nematode were associated with grapefruit, Citrus x paradisi Macfady, which showed decline symptoms and stubby roots (27).

SURVEY AND DETECTION: To detect whether ectoparasitic nematodes are causing a problem on citrus, it is necessary to submit the soil surrounding roots for laboratory analysis. Indicator symptoms for some ectoparasitic nematodes are stunted or stubby roots, and in some cases root swellings and galls. Aboveground symptoms caused by ectoparasitic nematodes may be similar to those caused by endoparasitic nematodes, i.e., stunting, sparse foliage, mild chlorosis of the foliage, and reduced fruit quality.

TABLE 1. Nematodes known to be pathogenic to citrus

Feeding Habits/Nematode	Regions where known to be pathogenic	Reference(s)
<u>Migratory Endoparasites</u>		
<i>Radopholus similis</i>	FL (U.S.A.)	24
<i>Pratylenchus brachyurus</i>	FL (U.S.A.)	5
<i>Pratylenchus coffeae</i>	FL (U.S.A.), India, Japan, Taiwan	14, 17
<i>Pratylenchus vulnus</i>	CA (U.S.A.), Italy	16, 18
<u>Sessile Semi-endoparasites</u>		
<i>Tylenchulus semipenetrans</i>	Worldwide	1, 7
<i>Meloidogyne</i> sp.	India & Taiwan	6
* <i>Meloidogyne exigua</i>	Surinam	12
* <i>Meloidogyne incognita</i>	Australia	10
* <i>Meloidogyne indica</i>	India	26
* <i>Meloidogyne javanica</i>	CA (U.S.A.) Israel	2, 19
<u>Migratory Ectoparasites</u>		
<i>Belonolaimus longicaudatus</i>	FL (U.S.A.)	22
<i>Hemicycliophora arenaria</i>	CA (U.S.A.)	25
* <i>Hemicycliophora nudata</i>	Australia	11
<i>Hoplolaimus indica</i>	India	15
<i>Trichodorus christiei</i>	FL (U.S.A.)	22
<i>Trichodorus lobata</i>	Australia	23
<i>Trichodorus porosus</i>	CA (U.S.A.)	3
<i>Xiphinema basiri</i>	Sudan	27
<i>Xiphinema brevicolle</i>	Israel	9
<i>Xiphinema index</i>	Israel	9

*Pathogen known to cause galls or other root abnormalities, but it has not been shown experimentally that these nematodes reduce the growth of citrus seedlings or trees.

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